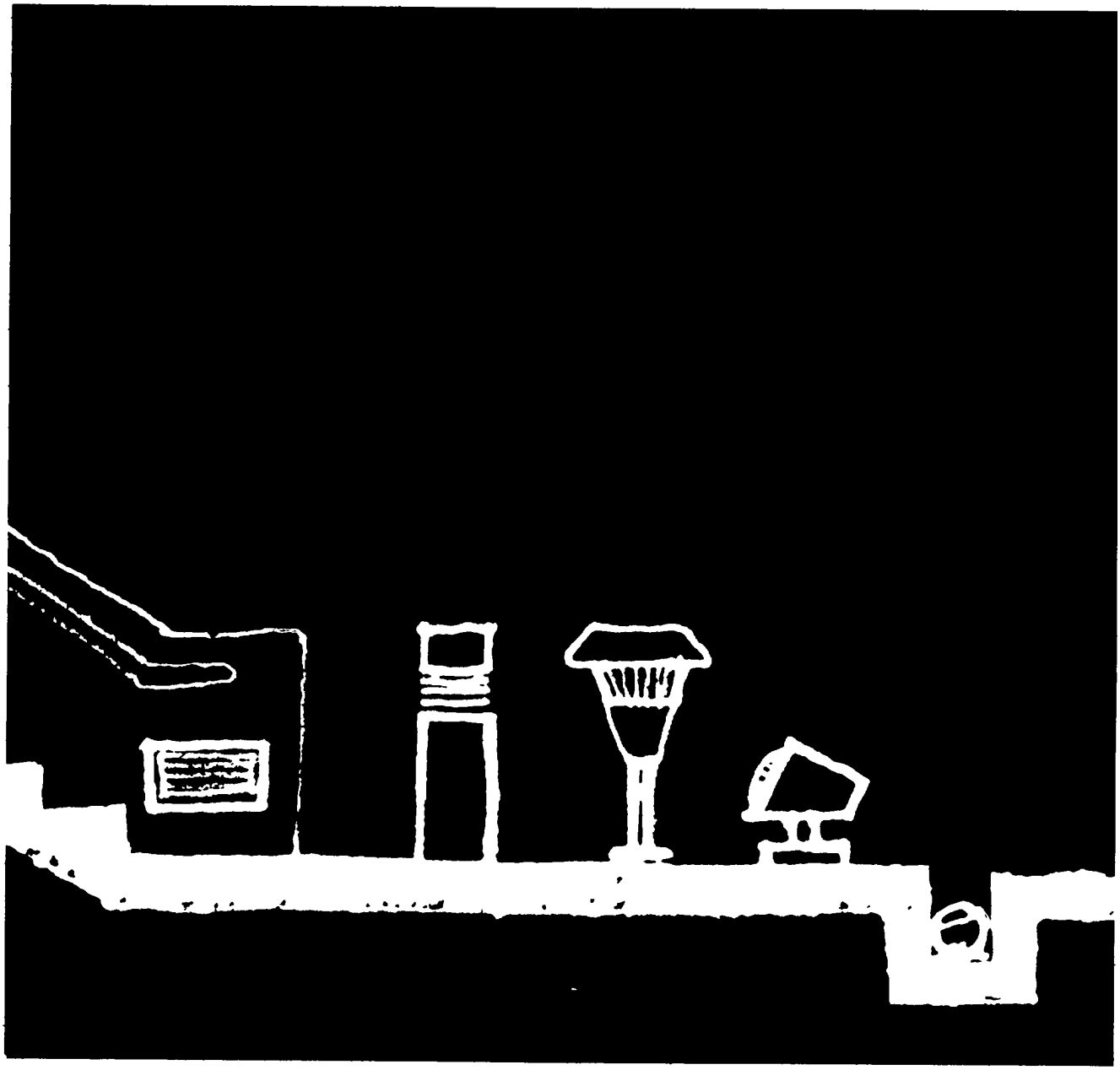
Lighting is a flexible medium with great potential to improve the visual character of an installation. Exterior lighting performs a number of functional uses, primarily related to nighttime safety, security and pathfinding. This is accomplished through a variety of applications to roads, walkways, plazas, parking lots, and buildings. Illumination levels, color rendition, lighting patterns and other aspects of outdoor lighting design can be varied with lamp type, illuminate type, as well as fixture location, spacing, mounting height and details. Generally, emphasis in the past has been placed on achieving a higher level of illumination rather than improving other qualitative aspects of outdoor lighting. Increased energy consciousness has forced a reappraisal of this emphasis on greater illumination levels. The design of outdoor lighting should be reoriented toward achieving a coordinated system that is attractive, functional and efficient.



Section I:

Observations and Objectives.

11-1.
Typical Problems.

A. Roadway Lighting.

1. Roadway lighting on military installations has often been provided on overhead utility poles at a constant spacing along one side of the road (*fig. 11-1*). This predetermined spacing may be inappropriate for the desired lighting design, and allows for little differentiation between streets of varying functions or land use

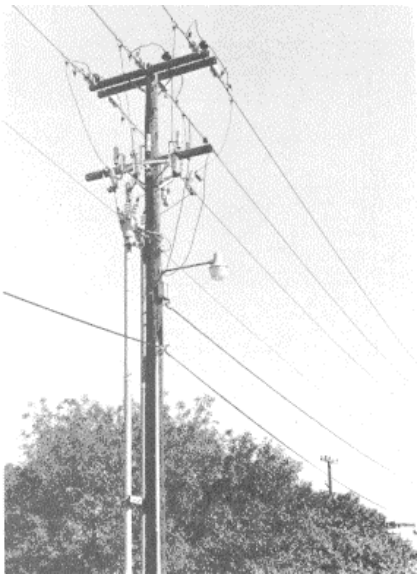


Figure 11-1.

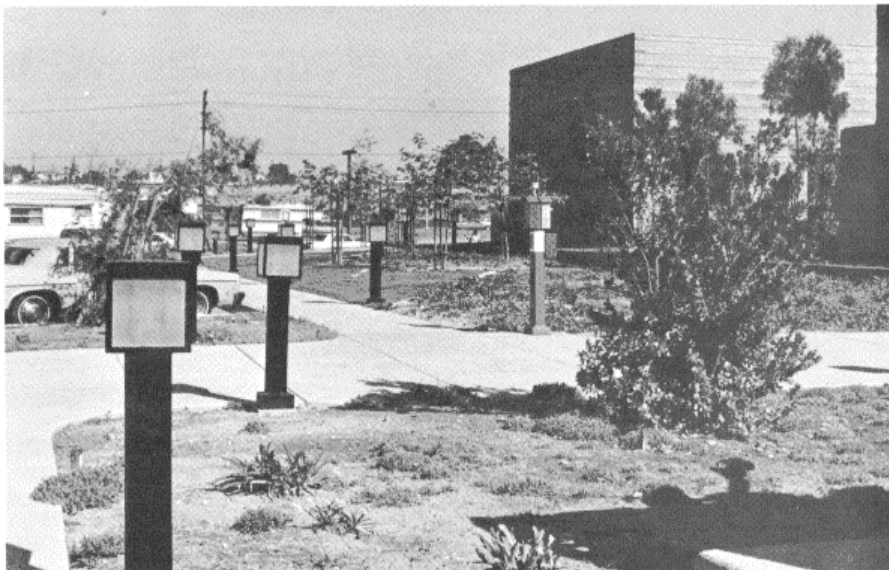


Figure 11-2.

districts. However, where underground utilities are not economically justifiable, attaching the luminaire to the utility pole minimizes the number of poles and thereby reduces visual clutter-along the streetscape.

2. Often the street lighting system does not serve to define the circulation hierarchy of an installation. Street lighting should visually reinforce the importance and function of the roadway by means of its fixture design and level of illumination to provide a visual sense of nighttime orientation to the motorist. On residential streets, the scale of lighting standards and high level of illumination is often inappropriate; in some cases unshielded luminaires have been used, resulting in discomforting glare.

B. Pedestrian Lighting.

Pedestrian facilities that are heavily traveled at night require lighting to illuminate the path and provide safety and security. Most of the pedestrian lighting observed on military installations has been associated with recent construction. Sometimes it is

Figure 11-3.

either overdone, stylistically incompatible with the adjacent surroundings, or highly susceptible to vandalism (*fig. 11-2).*

C. Parking Lot Lighting.

General illumination of parking areas is often needed for traffic as well as pedestrian safety and security, especially in high nighttime use areas. The recent trend in lighting large parking

areas using a relatively few, high mast standards is efficient from an engineering standpoint, but the scale of these standards is often in conflict with pedestrian activity and adjacent land uses (*fig. 11-3*).

D. Outdoor Architectural Lighting.

In some cases, outdoor lighting of buildings is used to highlight or accent a building at night. In general, this type of lighting should be avoided, except where building security is essential, or special effects are needed. Selective lighting of a few landmark buildings does, however, help provide a sense of orientation for nighttime motorists.

B. Overall Coordination.

Perhaps the most common visual problem that has existed with exterior lighting on military installations has been the lack of overall coordination. The style, scale, level of illumination and lamp type have often been applied inconsistently and have been uncoordinated in design.

11-2.

Objectives.

A. Express the Appropriate Image, Character and Scale of an Area.

Lighting should be related to the functions and scale of activities it serves. Lighting design should vary with the volume and type of traffic and with the visual character of development.. Street and pedestrian lighting should be coordinated with other elements of the streetscape, such as signing, landscape planting, paving materials, trash containers and bus shelters. A coordinated approach can greatly reduce visual clutter and confusion.

B. Convey a Sense of the Installation Organization.

At night, street lighting is the primary means of defining the hierarchy of the circulation system. By reinforcing this hierarchy and by illuminating signing and landmark features, exterior lighting can greatly contribute to a sense of orientation that enables people to easily find their way about the installation at night.

C. Promote safety and Security for Nighttime Use of the Installation.

For the nighttime driver, the lighting of roadways must illuminate obstructions and provide an understanding of oncoming conditions. This can reduce accidents and promote a better utilization of roadways by increasing safe speeds. Pedestrian lighting must also illuminate obstructions as well as provide a reassuring psychological feeling of security by minimizing dark shadows.

D. Minimize Operational Maintenance and Repair Costs.

Exterior lighting should be efficient and vandal-proof and should facilitate maintenance and repair.

Section II:

Design Guidelines.

11-3.

Basic Types of Exterior Lighting.

A. Low Level Lighting.

This type of lighting is provided by fixtures mounted at heights below eye-level and is typically

Figure 11-4.

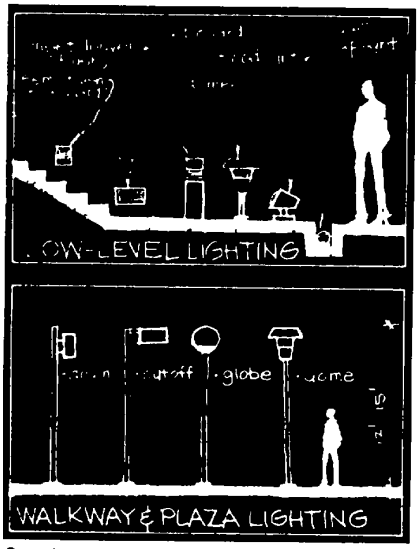


Figure 11-5.

used for special pedestrian walkway areas such as at stairways or along secondary pathways (*fig. 11-4*). It is characterized by very finite light patterns with low wattage capabilities. Light sources are either incandescent or fluorescent. They have simple maintenance requirements but are susceptible to vandalism.

B. Walkway and Plaza Lighting.
This type of lighting is provided by fixtures mounted at average heights between 12 to 15 feet and is used to light primary pedestrian walkways and plazas (*fig. 11-5*). They have potential multiple uses because of a large variety of fixtures and light patterns. Their light source is typically incandescent or mercury vapor. They are susceptible to vandalism.

Figure 11-6.

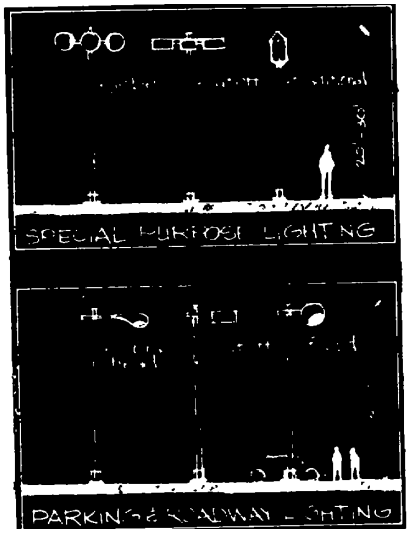


Figure 11-7.

C. Special Purpose Lighting. This type of lighting is provided by fixtures mounted at an average height of between 20 to 30 feet and is used in recreational, commercial, residential and industrial applications (*fig. 11-6*). The light source is typically metal halide or mercury vapor. Fixtures are maintained by gantry.

D. Parking and Roadway Lighting.
This type of lighting is provided by fixtures mounted at average heights of between 30 to 50 feet and is typically used in large

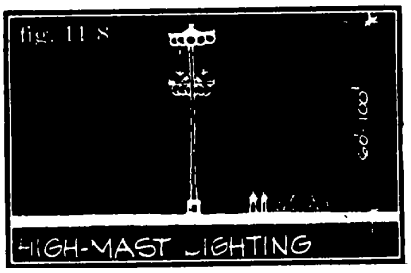


Figure 11-8.

recreational areas, parking lots and roadway applications (*fig. 11-7*). Light source is typically mercury vapor or high pressure sodium. Fixtures are maintained by gantry.

E. High Mast Lighting.
This type of lighting is provided by fixtures mounted at an average height of between 60 to 100 feet and is typically used- for large area lighting of parking lots, recreational areas and highway interchanges (*fig. 11-8).* Light source is typically mercury vapor or high pressure sodium. Fixtures must be lowered on the pole for maintenance.

11-4.
Visual Elements of Lighting Design.
There are a number of variables to be considered in the technical design of exterior lighting including the level of illumination, luminaire location and type of luminaire. It is not the intent of this section to provide a comprehensive methodology or set of standards for the design of exterior lighting, most of which exists in current military manuals on the subject (see TM 5-811-1). The intent of this section is to deal with those elements of lighting design that affect the visual quality of the environment. Therefore, discussion here is limited to visual considerations in selecting a lighting source and standard or pole.

A. Selection of Light Source.
A variety of light sources are available for exterior lighting, each with characteristic advantages and disadvantages which influence its appropriate use. A qualified illuminating engineer, in coordination with installation master planners, architects, landscape architects and civil engineers, should design the exterior lighting system and select light sources which are appropriate. The following general guidelines are offered here for appropriate use of various light sources on military installations.

1. High Pressure Sodium.
Because of its high efficacy, this lamp should be used for roadways and protective lighting systems, where relatively high lighting levels are required. The current trend in street lighting design incorporates this lamp in major street lighting design system s.

2. Metal Halide. This lamp type is recommended for use in "people-gathering" areas such as churches, theaters, auditoriums and shopping centers. This lamp has a good color rendition and is not psychologically offensive to people.

3. Color-Corrected Mercury Vapor. This lamp type is the least efficient source of the high intensity discharge family of lamps and is recommended for use in residential streets where lower lighting levels are desirable.

4. Incandescent. This lamp type should only be used in pedestrian areas or when its warm color-strengthening characteristic is necessary. This limitation on use is primarily because of its low efficiency and short life span.

B. Selection of Light Standards (or Poles).
Luminaries can be mounted on existing utility poles to limit

additional clutter. However, wherever feasible, exterior lighting systems should be provided with standards, or poles, that yield the proper spacing and mounting height ratios for a given light problem.

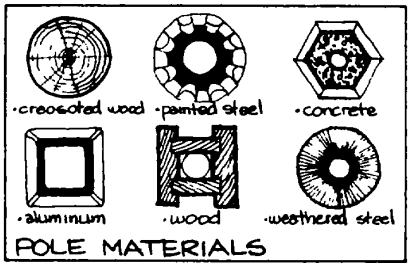


Figure 11-9.

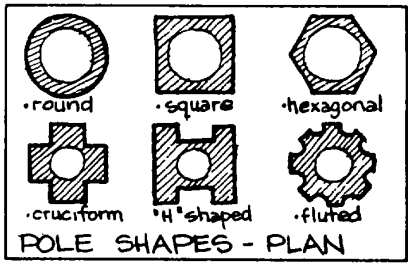


Figure 11-10.

1. Types of Standards or Poles. Lighting poles that are generally available include the following, listed in ascending order of expense: (*figs. 11-9, 11-10 and 11-11).*

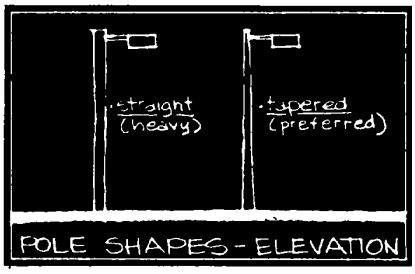


Figure 11-11.

a. Creosoted Wood. This pole type is purely utilitarian and should generally be avoided when establishing an overall lighting system for an installation. Its application should generally be limited only to where it already exists (replacement) or temporary poles.

b. Painted Steel. This pole type provides a trim profile but requires regular maintenance. Baked-on powdered paint coatings that minimize maintenance are available in some localities but add considerably to costs. Painted steel poles are best used in community areas, residential streets and pedestrian lighting applications. Generally, they should be avoided because of maintenance requirements.

c. Concrete. The quality of appearance of concrete poles varies considerably from utilitarian to exposed-aggregate finishes. These types of poles have height limitations (approximately 50 feet) and their profile becomes large and visually cumbersome or heavy as their height increases. They require minimum maintenance and can be used in a variety of applications, except high mast uses. They generally blend well with the natural and architectural setting, especially when weathered or containing earth-tone aggregates.

d. Aluminum. These types of poles provide a thin profile and require little maintenance. They are available in a variety of finishes, but when left natural should have a brushed finish to minimize reflection and glare. They are best used in a variety of applications including community areas, residential streets and pedestrian lighting. Their major drawback is initial cost, which can be offset in life cycle cost by their low maintenance requirements.

e. Weathered and Decorative Wood. These types of poles are generally considered for special area applications where a high quality finish is desired that blends with the aesthetics of a particular setting, especially in pedestrian or residential areas. They are relatively expensive and susceptible to defacement by vandals.

f. Weathered Steel. This type of pole is best used where high mast poles or minimum maintenance is required. This type of pole should be avoided in any areas where pedestrians might come into physical contact with the pole because of its staining characteristic. Initial costs are high but its practicality for high mast applications is more than justified because it is relatively maintenance-free.

2. General Selection Guidelines. Standards or poles should be selected based upon their functional and aesthetic appropriateness.

a. Generally, concrete and aluminum poles are the most attractive and practical systems for poles up to 50 feet in height.

b. Weathered steel poles should only be used for high-mast type lighting in areas where no pedestrian contact occurs.

c. The pole system selected should be used consistently throughout the installation.

d. Different pole types can be used for different systems, i.e., vehicular and pedestrian, but they should relate harmoniously, especially in areas where they may interface.

11-8.

Information and Orientation.

A well-designed street lighting system should define the circulation hierarchy of the installation (*see Chapter 4*), expose traffic conditions, and provide visual orientation to help both pedestrians and drivers find their way at night. During the daytime, the repetitive lighting standards should also contribute to this hierarchy and sense of order.

A. Reinforcing the Street Hierarchy.

Lighting should reinforce the street hierarchy by visually differentiating primary, secondary and tertiary streets. These differences in street importance should be expressed by varying the levels of illumination and the type, height and spacing of lighting standards. An example of hierarchical street lighting design is illustrated here. While specific elements of the lighting system will vary with the unique requirements of each installation, the functional/visual concept illustrated here should be consistently applied at all installations.

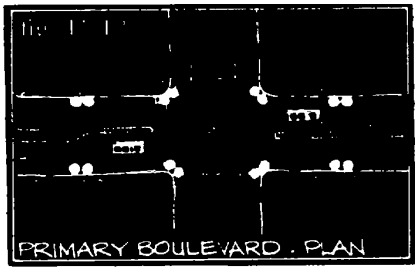


Figure 11-12.

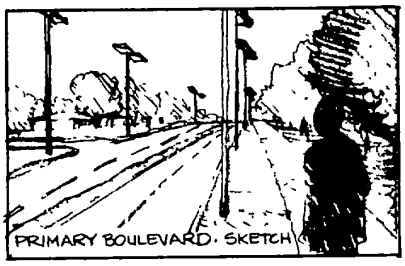


Figure 11-13.

1. Primary Boulevard or Wide Primary Street.

Regularly spaced, paired luminaires mounted on 40-foot standards in an opposite arrangement (both sides of the street) define a primary boulevard or a wide primary street (*figs. 11-12 and 11-13*). In character, this is definitely an automobile-dominant road. When the basically continuous traffic flow is interrupted at a full intersection, the distinct pattern of an outdoor "room' clearly indicates a junction. Major corners throughout the system are defined as outdoor "rooms" by the relationship of paired luminaires, arrangement of signal lights, illuminated street names, striped crosswalks and perhaps even a change in pavement color for the enclosed rectangular area at the intersection.

2. Primary Street.

Primary streets of narrower width are identified by regularly spaced, paired luminaires mounted on 40-foot standards along one side of the road *(figs. 11-14 and 11-15).* Preferably this side would be opposite the trees

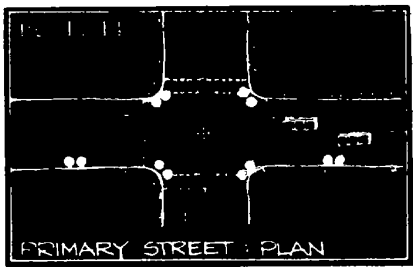


Figure 11-14.

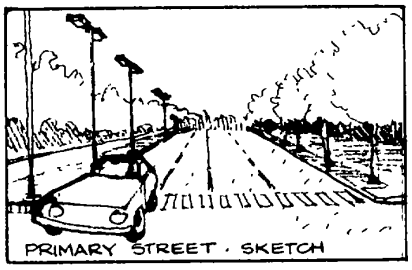


Figure 11-15.

or view. The illumination level is made higher at intersections so that drivers and pedestrians will be alerted to cross traffic.

3. Secondary Street.

Single luminaries placed opposite each other on 25-foot standards define a secondary street (*figs. 11-16 and 11-17*). Staggered spacing should be avoided because of the confusing, disorderly patterns which result, particularly on curves. The lighting is in obtrusive due to the straight-line design of the poles and the minimum luminaire overhang.

4. Boulevard (Secondary or Tertiary). Paired lumlnaires on 25-foot standards in the median are utilized for these boulevards (*figs. 11-18 and 11-19*). A variation in lamp type (color corrected mercury for residential, high pressure sodium for other areas) could distinguish an area's land use. Intersections on a more heavily used street are marked by paired luminaires on 40-foot poles.

5. Tertiary Street. A typical tertiary residential street is identified by a single color-corrected mercury fixture at one side mounted on 15-foot poles

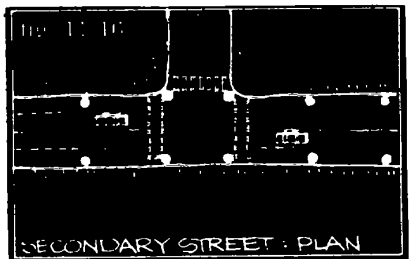


Figure 11-16.

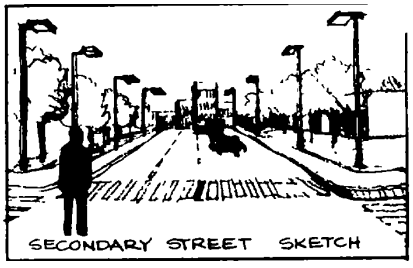


Figure 11-17.

(*figs. 11-20 and 11-21*). Intersections with similar residential streets are defined by pairing the fixtures. Intersections with a secondary or primary street are defined by lighting fixtures on 40-foot poles.

B. Landmarks.

Lighted buildings, monuments, fountains and other structures can serve as orientation landmarks for the nighttime driver. Care must be taken not to over-

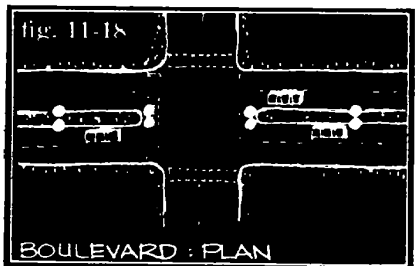


Figure 11-18.

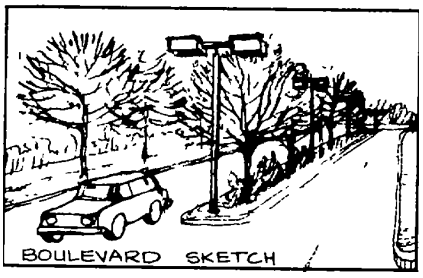


Figure 11-19.

do such lighting which would both detract from overall effectiveness and be wasteful of energy.

C. Site Furnishings.

Certain street furniture, such as fire alarms, but shelters and signing should be properly lighted for nighttime use.

11-6.

Image, Character and Scale.

A. Finish.

In order that street lighting not dominate the streetscape but serve as background, the materials should have a matte finish to avoid distracting reflections and highlights

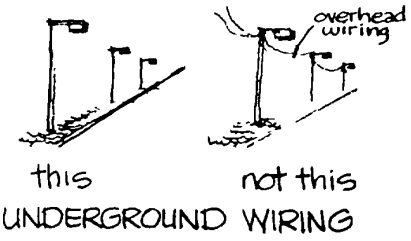


Figure 11-22.

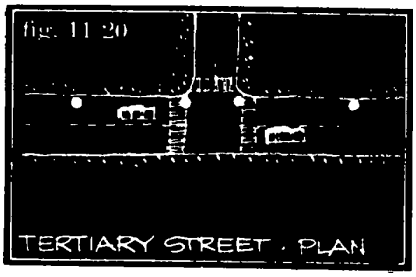


Figure 11-20.

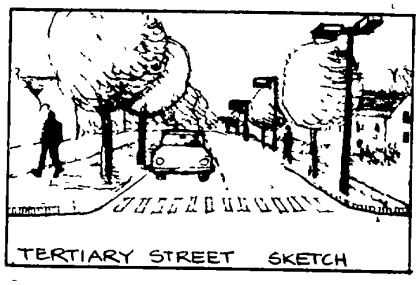


Figure 11-21.

B. Power Supply.

To reduce streetscape clutter, it is highly preferable to supply power by underground rather than overhead lines to fixtures wherever possible and practical (*fig. 11-22*).

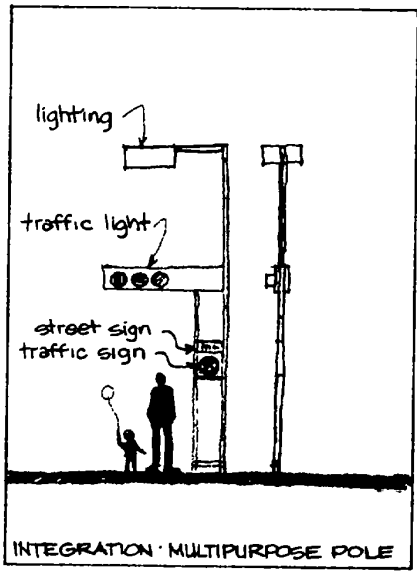


Figure 11-23.

C. Integration with Other Site Furnishings.

In order to reduce clutter, lighting standards should be integrated in design with street signs, traffic signs and signals (*fig. 11-23).*

D. Built-up/Non-Residential Areas.

In built-up areas, lines and planes of the fixtures should relate to buildings (poles vertical and arms horizontal) and overhanging arms and large directional fixtures should not dominate the view (*fig. 11-24).*

E. Residential Areas.

Commercial-sized standards, high-wattage lamps and unshielded luminaires should not be used in residential streets.

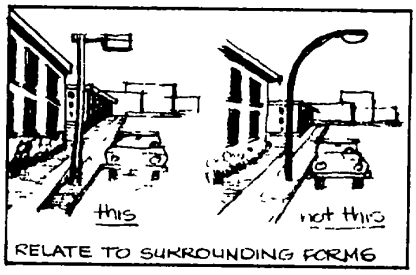


Figure 11-24.

F. Pedestrian Areas.

In areas of high pedestrian activity, warm color light sources of low intensity should be used. Low lighting standards or poles should be used to maintain the proper scale.

G. Historic Areas.

In historic areas, lighting should be compatibly designed with the architectural setting. However, it should not be imitative of lighting that is no longer available, such as electrified "gas" lamps.

11-7.
Safety and Security.
The primary purpose of exterior lighting is to provide a safe and secure nighttime environment. The illumination requirements should vary with the activities being performed and user needs.

A. Vehicular.

1. The driver must be able to see distinctly and locate accurately and quickly all significant details, such as the alignment of the road, any potential obstacles, signing and traffic control devices.

2. Intersections and other complex or irregular road configurations, such as curves, hills, converging traffic lanes, diverging traffic lanes or pedestrian crossings, require higher illumination levels. The illumination level for an intersection should be the summation of the levels of the intersecting roads (*fig. 11-25).*

3. In addition to higher illumination levels, the placement of lighting standards along curves is important to reveal to the driver, both by day and by night, the oncoming alignment of the roadway. Fixtures only on one side provide a clear and attractive pattern, as opposed to staggered fixtures on both sides, which are distracting by day and confusing by night (*figs. 11-26 and 11-27*).

4. Lighting standards should be placed so that they are not hazardous to pedestrians or vehicles. If a poor placement cannot be avoided, breakaway pole mounting details should be employed.

5. Disability glare, or glare that reduces the viewer's ability to see an object, should be controlled by careful attention to luminaire location and the use of cutoff or semi-cutoff luminaires.

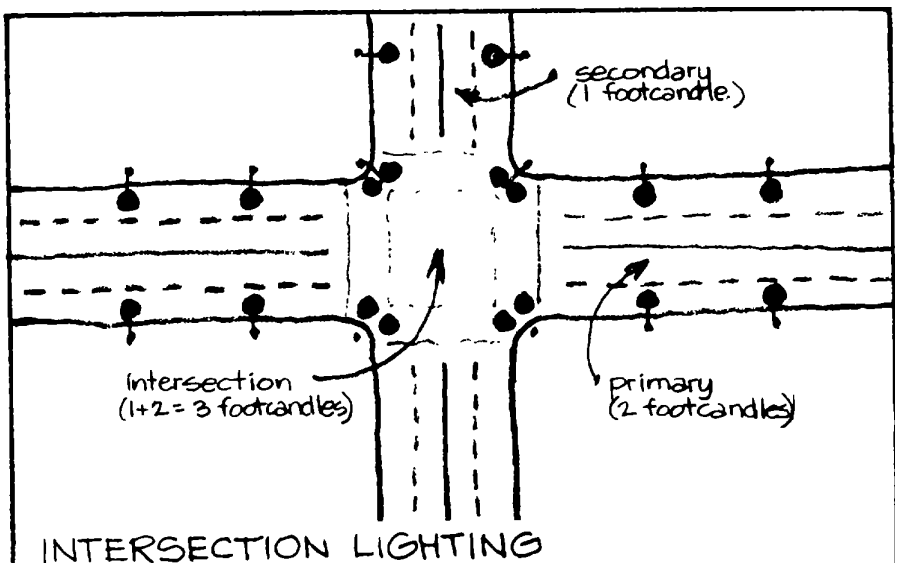


Figure 11-25

B. Pedestrian.

1. The pedestrian must also be able to see distinctly such features as the edges of the walkway, vehicles and obstacles.

Figure 11-26.

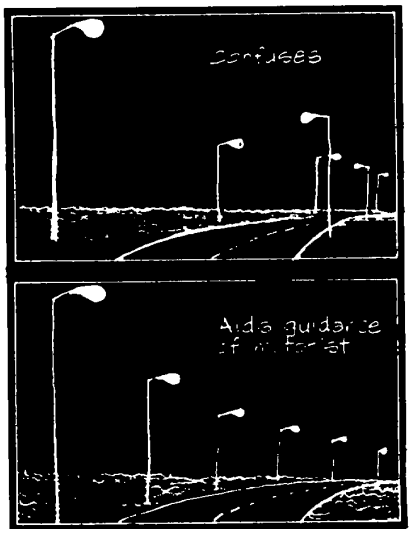


Figure 11-27.

2. In addition, the pedestrian has significant psychological nighttime needs requiring that dark shadows should be minimized to provide a sense of security.

3. Hazardous locations along pedestrian paths, such as changes in grade, require higher illumination levels or supplemental lower level lighting.

4. Light standards should be located so as not to impede pedestrian flow along walkways.

11-8.
Economy, W4fntenance and Repair.

A. The location, height and details of lighting standards should allow easy maintenance and replacement of luminaires and lamps.

B. High-efficiency, long-life lamps should normally be utilized. Incandescent and color corrected lamps should be used as accents and in pedestrian areas.

C. Vandal and accident-prone mountings and luminaires should be avoided.